High-Fidelity Multiphase Simulations and In-Situ Visualization Using CIAO

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Motivation

- Emission and pollutant formation in engines strongly depend on injection systems and resulting cavitation
- Experimental investigation of injection systems very challenging due to small length (~100 µm) and high velocity scales (~600 m/s)
- Highly resolved simulations result in large amount of data which can be reduced with in-situ visualization

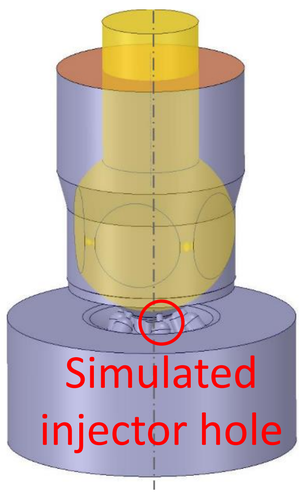
➢ Predictive simulations using in-situ visualization and studying injection systems and resulting cavitation very helpful!

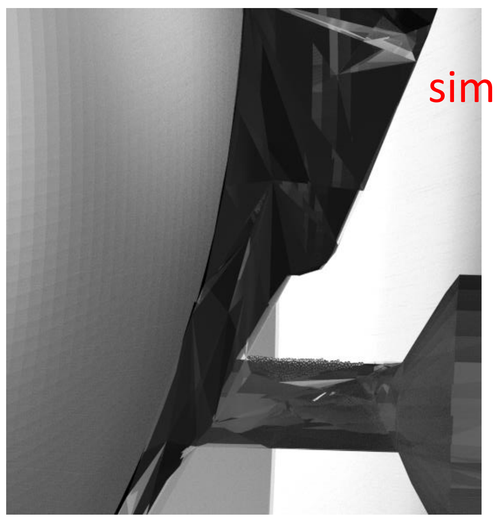
Spray demonstration movie (JARA booth SC15, Austin)

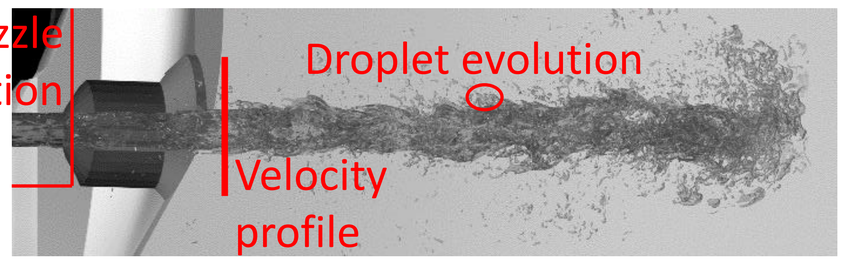
CIAO

- Multiphysics, multiscale Navier-Stokes solver (LES and DNS) for turbulent reacting flows in complex geometries
- Fortran & MPI
- Structured FD
- Low Mach & Compressible
- Overset for local mesh refinement
- EOS-lookup-based cavitation model[1]
- 3d unsplit CLSVOF approach and monotonicity preserving Lagrange-Remap solver for interfacial flows
- Coupled Eulerian primary breakup/Lagrangian spray simulations[2]

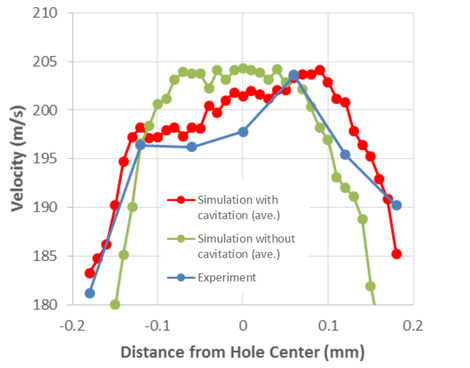
Multiphase Simulation Results



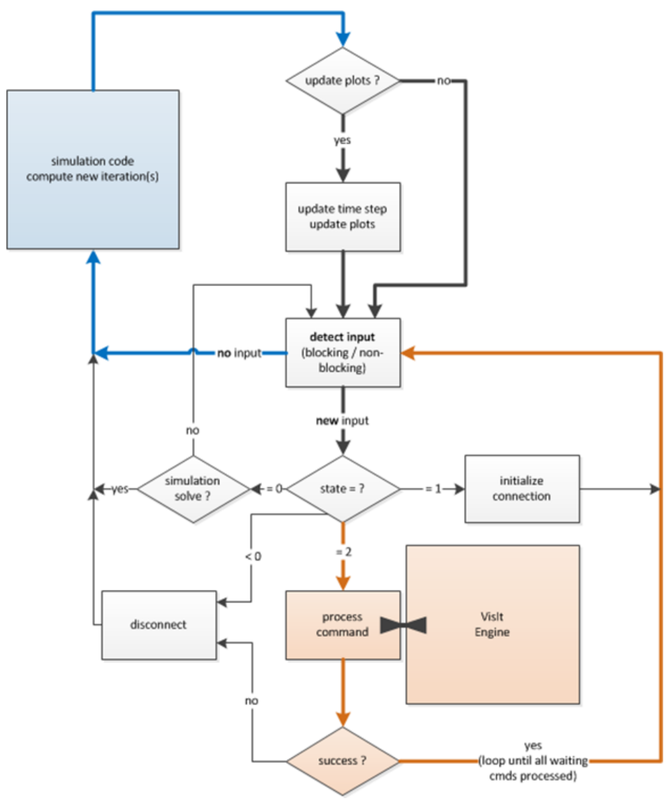


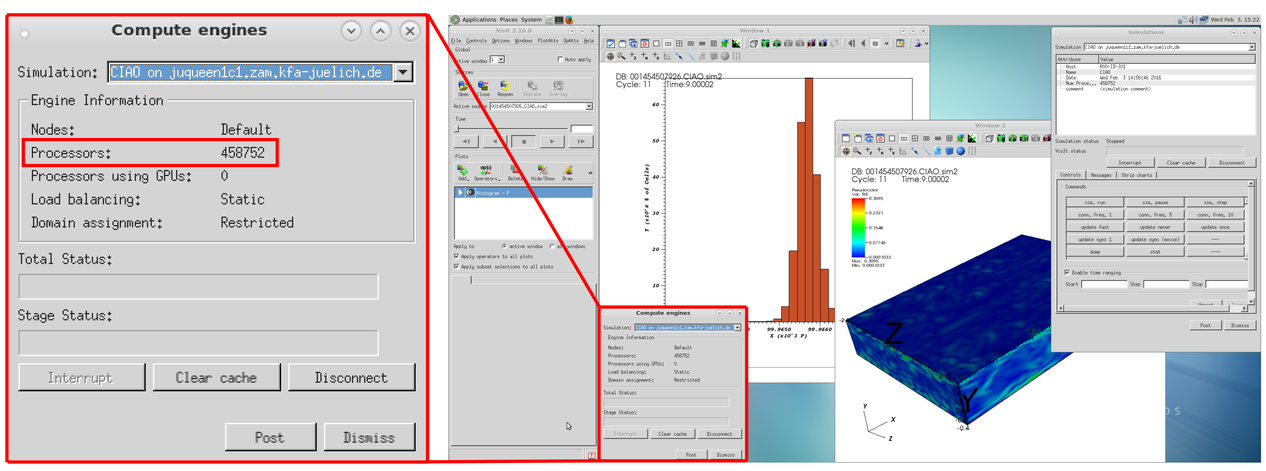


- Compressible nozzle simulation (left)
- Primary breakup simulation (center)
- Velocity profiles at nozzle exit (top right)
- Single droplet evolution (bottom right)



In-Situ Visualization





- JUSITU[3] as coupling layer between the multiphysics flow solver CIAO and the visualization and analysis tool VisIt[4]
- Flow chart (left) of JUSITU implementation
- Screenshot (top) of successful CIAO/VisIt run on full JUQUEEN with turbulent channel/droplet case

References

[1] Bode et al, ICLASS 2016 [2] Bode et al, SAE WC 2016
[3] https://trac.version.fz-juelich.de/vis/wiki/VisIt
[4] https://wci.llnl.gov/simulation/computer-codes/visit/

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